Use of sediment quality guidelines in damage assessment and restoration at contaminated sites in the United States

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RON GOUGUET

Today we live in modern societies that rely on complex manufacturing and transportation networks to support our large populations and burgeoning growth. We move tremendous quantities of fuels and toxic chemicals to support our lifestyles. Sometimes these commodities are accidentally released into the environment. We typically react to stop the release and mitigate its impacts; these first immediate steps often evolve to long-term remediation to clean up the spill. Chronic toxic chemical releases or historical persistent chemical releases can also have adverse effects on natural resources. Generally, the release has had some impact on natural resources. If the contaminants have the potential to cause harm to the environment, active measures (i.e., cleanup) may have to be employed. The additional impact of cleanup activities can be substantial in the medium term. This "collateral damage" should be taken into consideration during spill response. This chapter describes an approach that uses sediment quality guidelines (SQGs) and other lines of evidence (LOEs) in the cooperative evaluation of benthic injury due to sediment contamination.

Natural Resource Damage Assessment in the United States

Most societies value natural resources: their birds, crabs, fish, turtles, water, air, etc. The United States broadly categorizes natural resources such as land,

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fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources into 5 groups:

1) surface water resources,
2) groundwater resources,
3) air resources,
4) geologic resources, and
5) biological resources (43 CFR §11.14 (z)).

Society places value on the resources or their uses; that is, the societal value of the resource. "Natural resource services" is a concept used to measure the societal value of the physical and biological functions performed by the natural resources, including human uses of those services and services to other resources and ecosystems.

In the US, federal and state laws provide a scheme to compensate the public for the loss of natural resources and their services using natural resource damage assessment (NRDA) and compensatory restoration. The purpose of an NRDA is to determine the quantity of the losses and create habitat, increase stocks, or otherwise provide additional natural resources and services to compensate for the lost resources and services that result from a chemical or oil release to the environment. Rules for conducting NRDAs were developed by the US Department of the Interior (43 CFR Part 11) and the National Oceanic and Atmospheric Administration (NOAA; 15 CFR Part 990). European, South American, and Southeast Asian governments also have begun to consider losses of their natural resources that occur when oil or hazardous chemicals are accidentally released into the environment.

Sometimes we are lucky and a release dissipates quickly (Figure 14-1, scenario 1), so there are few impacts to natural resources and little loss of natural resources or their services. Sometimes our cleanup activities are quite successful and have little long-term impact, themselves, on natural resources (Figure 14-1, scenario 2). In each of these cases, while some organisms and habitats are briefly affected, few medium- to long-term impacts remain in the environment. (Figure 14-1, scenario 2). In another situation, a more persistent, more toxic, more difficult to remove release would generally result in many organisms and habitats being affected on a medium- to long-term basis (Figure 14-1, scenario 3).

Under the US Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 122j, trustees have the authority to release potentially responsible parties (PRPs) from natural resource damages liability if PRPs take appropriate measures to protect and restore injured natural resources. Under

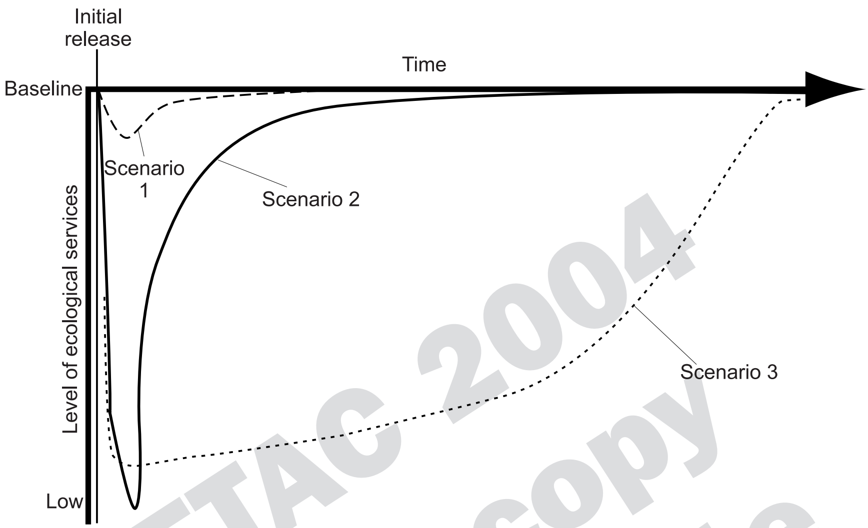


Figure 14-1 Simplified natural resource service loss and recovery curves associated with oil or hazardous substance release scenarios

CERCLA, trustees authorized to act on behalf of the public include the federal and state government and Native American tribes (40 CFR §300.600). The approach described here protects and restores coastal natural resources by collaboratively resolving natural resource liability as part of or in parallel to the cleanup process. By working with the responsible parties and trustees during the cleanup process, trustees can quickly and efficiently plan for and cooperatively implement restoration actions that compensate the public for natural resource injuries, including interim service losses, caused by contamination.

Achieving restoration of injured resources requires that the following questions be answered:

- What measures must be taken to protect natural resources from existing and future threats?
- What resources have been injured, and what is the loss to the public?
- How can the resources be restored, and what type and amount of restoration are appropriate to make the public and the environment whole?

Integration of the trustees into the site characterization, risk assessment, and cleanup planning process ensures that the first question above is answered at the appropriate point in the cleanup process. The damage assessment and restoration planning process addresses the last 2 questions and has 3 primary phases: injury assessment, restoration planning (including identification, evaluation and selection from among restoration alternatives and scaling of restoration), and restoration implementation. "Injury" means a measurable adverse change, either long or short term, in the chemical or physical quality or the viability of a natural resource, resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance or from exposure to a product of reactions resulting from the discharge of oil or release of a hazardous substance [43 CFR Part 11]. This chapter explains a way of cooperatively scaling natural resource injuries and restoration. Regarding estuaries of coastal Louisiana and Texas, the trustees and cooperating parties have evaluated injury to benthos and loss of benthic services (LOBS) using SQGs and SQG indices (Texas Trustees 2001).

Barnthouse and Stahl (2002) provide views on specific approaches drawn from ecological risk assessment (ERA) practices that could improve NRDA. Their recommendations refer to the conduct of rigorous and costly investigations that could be required of trustees to prove NRDA claims. They state that, "Perhaps the greatest challenge facing Trustees and PRPs involved in NRDA proceedings is the development of an assessment process that leads to cost-effective and properly scaled restoration of natural resource services." The approach outlined herein has been successfully applied to meet this challenge.

Ecological Risk Assessment and Risk Management: Trustee Integration

ERA is used to determine the probability that an ecological receptor (resource) will be harmed through exposure to a particular hazardous substance in its environment (USEPA 1997). Some form of ERA is usually performed as part of risk-based corrective action investigations under various environmental statutes (e.g., US CERCLA, Texas Risk Reduction Rule, US Federal Water Pollution Control Act [FWPCA]). The US Superfund ERA process consists of several steps, ranging from screening to risk characterization (USEPA 1997). A properly conducted risk assessment will provide useful information to guide the party responsible for cleaning up the release. Ideally, trustees' concerns are integrated into work plans for the remedial investigations (which determine the nature and extent and risk) to reduce potentially duplicative studies and efficiently fill any data gaps without additional studies.

Typically, conservative SQGs are used in an initial screening step when ecological risk to benthos from oil or chemical releases is assessed (USEPA 1997). If the environmental concentration of the particular toxic substance is higher than its respective, conservative SQG (e.g., effects range low [ERL]), then that contaminant is carried forward in the ERA. Further investigation during the

ERA must generally be conducted to determine if that contaminant significantly contributes to risk to benthos at the site. For many contaminants, no-observed-adverse-effect levels (NOAELs) and lowest-observed-adverse-effects levels (LOAELs) define the "risk range" within which benthos risk can safely be managed (USEPA 1997). The "risk range" defines contamination levels identified as posing no ecological risk and the lowest contamination levels identified as likely to produce adverse ecological effects on the benthos assessment endpoint (USEPA 1997).

Agreement on conservative ecological risk management at screening levels (or NOAEL) can be the most appropriate strategy, provided the costs in collateral damage and dollars are acceptable. This option should be considered when small areas are to be addressed and can save the time and expense of a "full-blown" ERA (Chapter 4). USEPA defines this as a "removal action" to screening concentrations (USEPA 1992). More complex sites require more in-depth analysis and comparison of more complex cleanup alternatives (Chapter 6).

Cooperative Injury Evaluation and Restoration Scaling

For the past decade, the Texas and Louisiana Trustees have been cooperatively engaged with PRPs in a cooperative approach to NRDA. Reasonably Conservative Injury Evaluation (RCIE) uses existing information from remedial investigations and other data sources, along with information from the scientific literature and other sites, to develop restoration packages that compensate the public for natural resource injuries at a site. In these states, the trustees' concerns for the chemical characterization investigations, risk assessments, etc., are often integrated into state or federal required remedial work plans. Additional injury assessment studies rarely have been required.

The Texas and Louisiana Trustees' RCIE approach to NRDA recognizes that it is sometimes better to make reasonable, conservative estimates of natural resource injuries or losses, using information obtained for other purposes, than to spend additional time and money on injury assessment studies. In the RCIE approach, the parties seek to err on the side of conservatism in favor of finding "resource injury" for an exposure level which at least one data or information source indicated was reasonably likely to result in an adverse effect. Integration of the trustees' unique concerns and perspective into the site characterization and risk assessment processes nearly eliminates the need for additional NRDA data in areas of overlapping concern.

Conservatism versus uncertainty

An underlying principle of RCIE is that there is a relationship between the need for conservatism, the uncertainty in the assessment, and the cost of reducing the need for conservatism and uncertainty (Figure 14-2).

Uncertainty is high when little is known about the nature or scale of an injury; in this case, a higher estimate of injury is assumed to be needed to ensure that enough compensation was provided. Additional information is needed to reduce uncertainty and the need for conservatism. However, additional information comes with costs in time and money. Early in the RCIE process when there is a great deal of uncertainty, acquiring some additional information can efficiently reduce the need for a conservative injury estimate. However, as an example of the law of diminishing returns, reducing uncertainty in the estimate can become less cost efficient, especially when continuing transaction costs are taken into account. At some point, the additional costs to refine conservative injury estimates do not justify further investment considered against the costs of providing additional habitat as compensation (this assumes that resources are protected from future or ongoing harm). In this case, the trustees and PRPs often can agree that sufficient information has been obtained to reach an agreeable level of certainty and that the issue at hand can be settled.

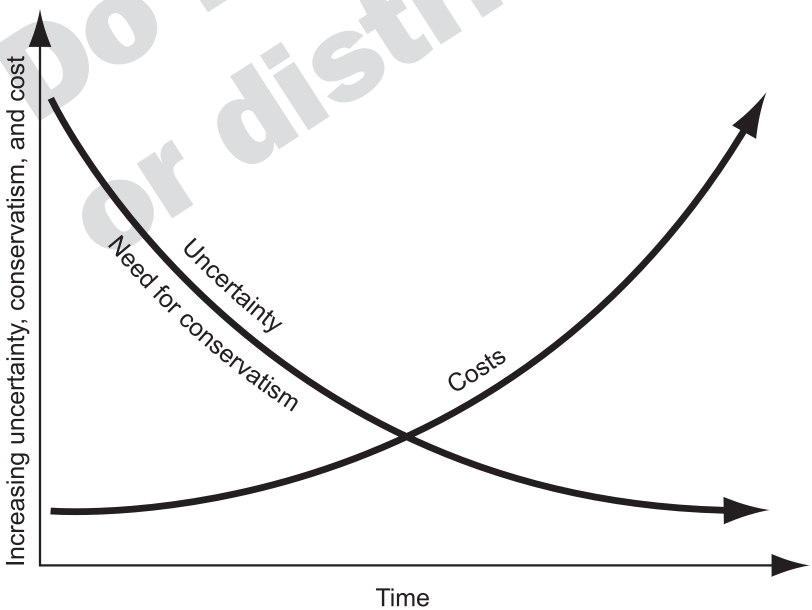


Figure 14-2 Idealized representation of the relationship between the need for conservatism, uncertainty, and the cost of reducing the need for conservatism and uncertainty in the RCIE process

RCIE scaling approach

As an early step at any site where RCIE is being considered, the trustees and PRP should assemble all relevant data and information bearing on the injury to each resource, preferably in an electronic database. Reliable historical data, data collected as part of any remedial process, and the results of prior relevant scientific studies or literature reviews should be located and included in the database. These data and any relevant historical data ideally should be managed in a relational database linked to a geographical information system (GIS) and freely shared among the trustees and the PRP. The RCIE approach attempts to match the weight of information with the weight of the decision to be made.

Generally, RCIE scales restoration of spatial units (habitat acres) using the appropriate SQG or some other benchmark or index (See "Use of Sediment Quality Guidelines in Benthic Community RCIE," p 597), GIS, and habitat equivalency analysis (HEA). Under US CERCLA, the public is considered to have been made whole for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre year (DSAY) as the "common currency" for comparison of the public's value of past injury and future restoration in a common time frame (Julius 1998). One service acre year is defined as the ecological service provided by 1 acre in 1 year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1998). So, 1 DSAY is the service provided by 1 acre in 1 year "discounted" to net present value. Area of injured habitat, percent loss of ecological services, duration of injury, etc. are considered in HEA to determine DSAYs. The public is made whole when replaced resources and services equal lost resources and services, that is, when the areas under the curves are equal (Figure 14-3).

Screening-level RCIE

Under the screening-level RCIE approach, before proceeding to plan and implement any specific studies to further investigate and/or quantify any resource injury or loss, the trustees and PRP should try to reach agreement on resource injury determinations on the basis of the available data and scientific information, using conservative scientific assumptions. Where sufficient information exists to support technically sound and reasoned analyses, injury determinations can be based on that information, by agreement of the parties.

For the Texas RCIE, a database built by the trustees or provided by the cooperating party is used by the trustees to make a conservative, screening-level estimate of injury and scale it to a preferred restoration option. The trustee con-

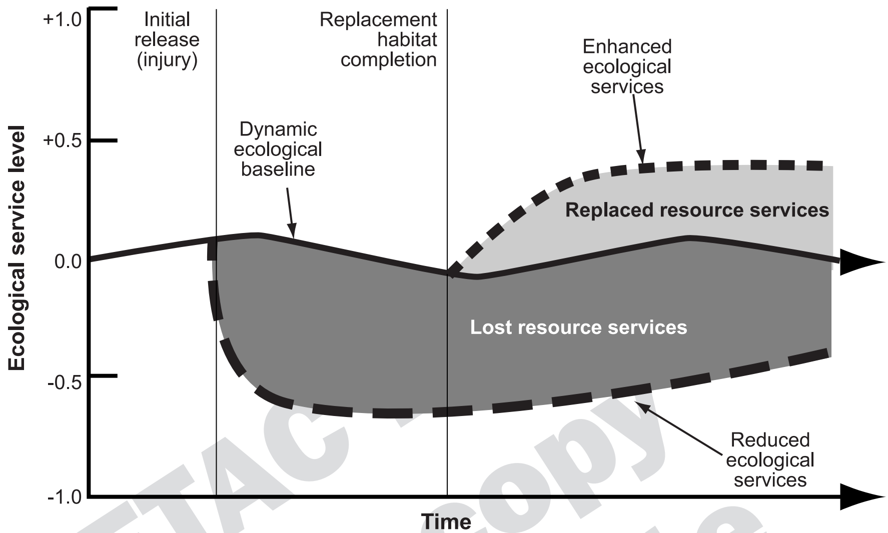


Figure 14-3 Timeline for a habitat equivalency analysis (HEA) used to determine the scale of restoration needed to just offset losses of resources and services

siders the remedy, any construction damage to the environment, any natural recovery period, and conservative, habitat-specific injury thresholds to develop an estimate of the lost DSAYs of the preferred habitat type. This value is discounted to determine a finite number of habitat units required by the trustees (NOAA 2000). If the PRP wishes to apply an additional level of rigor to the assessment, the trustees prefer that a memorandum of agreement (MOA) be developed to conduct a cooperative assessment.

Collaborative RCIE

Using a database built by the trustees or provided by the cooperating PRP, both parties can agree upon reasonable, conservative estimates of injury and scale the extent of the injury to a preferred restoration option. Both parties can consider the remedy, any construction damage to the environment, any natural recovery period (USEPA 2002), and conservative, habitat-specific injury thresholds to develop a estimate of the lost DSAYs of the preferred habitat type. This value is discounted (NOAA 2000) to determine a finite number of habitat units required by the Trustees, with agreement from the cooperating party.

If the estimate of injury is too uncertain and the parties cannot agree on the scale of the injury or if sufficient information is not available to make a reasonable estimate, then specific NRDA injury studies should be jointly developed to address the data gaps critical to determining or quantifying that resource injury, and the assessment process should be continued for that resource. The trustee and the PRP, through their participation in the cleanup process, strive to ensure that any additional data or samples would be taken simultaneously with response samples to answer injury-specific questions. Uncertainty and conservatism about various parameter estimates can usually be revised on the basis of additional, high-quality, site-specific data.

Where agreements can be reached, the resulting injury determination can then be used to quantify the injuries to that resource using tools such as GIS and sediment recovery models as input to HEA (NOAA 2000).

If a conservative review of the available data and literature indicate that there is little or no reasonable likelihood of an injury occurring, then the assessment process should conclude with a finding that no further consideration of that resource injury category is required.

Each resource injury determination agreed to by the trustees and the PRP using the RCIE approach should be memorialized in a jointly developed document that describes the methods and information on which the agreed assessment of injury is based.

Use of Sediment Quality Guidelines in Benthic Community RCIE

When injury to the benthic community is assessed, agreement on injury thresholds based on SQGs can lead to rapid agreement with trustee agencies when the RCIE approach to injury assessment is followed. SQGs can be used as reference points during the negotiation of injury values. Generally, marginally exceeding a single conservative SQG provides less evidence of potential injury than exceeding multiple SQGs or greatly exceeding an individual SQG. Generally, a higher level of resource injury would be assumed as the number of less conservative SQGs increased (Long et al. 1995, 1998). SQG-based sediment injury determinations have been conducted using SQG exceedances and SQG quotients elsewhere in the US (Ingersoll et al. 2002; MacDonald, Moore, et al. 2002).

The trustee and the cooperating PRP develop the scale that describes level of injury (LOBS) associated with the rate of increase in the contaminant gradient. A reasonably conservative threshold, near the LOAEL, is typically selected for the onset of injury. In some cases, ERL and ERM values are thought of as NOAEL and LOAEL values (Long et al. 1998). Similarly, threshold effects level–probable effects level (TEL–PEL; MacDonald et al. 1996), threshold effects concentration–probable effects concentration (TEC–PEC; MacDonald et al. 2000) pairs can be used, depending on ecosystem characteristics; the PEL, PEC, ERM most often are used. Less conservative SQGs (e.g., individual apparent effects threshold [AET]) can be agreed upon to represent an increased level of severity of injury, allowing construction of a "scale of potential benthos injury."

The trustees and cooperating PRP can agree on LOBS based on comparison of site chemistry and injury thresholds based on SQG. GIS allows quantification of spatially explicit injury maps to quantify injury areas and tally LOBS. Applying these agreed-upon injury thresholds using GIS allows quantification of consequences of exposures that affect only part of a population or the spatial distribution of organisms.

Severity of endpoints and scale of benthos injury

Mortality (loss of biomass) or lost reproductive capacity are on the upper end of the injury scale and would have a greater LOBS value; biomarkers without a clear, scalable connection would have a lower LOBS value; behavioral endpoints (e.g., avoidance, reburial, and aggressiveness) are usually considered intermediate LOBS values. More sensitive endpoints are considered to contribute less to the LOBS fraction than are less sensitive endpoints. The assumption is that if you observe a response with a less sensitive endpoint, then more sensitive endpoints are accounted for and a greater portion of the population potentially is affected, thus LOBS increases. There are some indications that, when the SQG quotient for a particular contaminant is low, only highly sensitive endpoints show effects (Chapter 4).

Sediment quality guideline indices

A higher probability of injury to the benthic community can be shown using multiple contaminant models such as mean ERM quotient, mean PEC quotient, or logistic regression P-Max model (Long et al. 1995, 1998; Field et al. 2002). As part of a comprehensive investigation of hazardous substance releases, the USEPA conducted the Calcasieu Estuary Ecological Risk Assessment (MacDonald, Moore, et al. 2002). In the benthic community risk portion of the investigation, site mean PEC quotients were compared to the results of amphipod acute and chronic toxicity tests (Figures 14-4 and 14-5). The

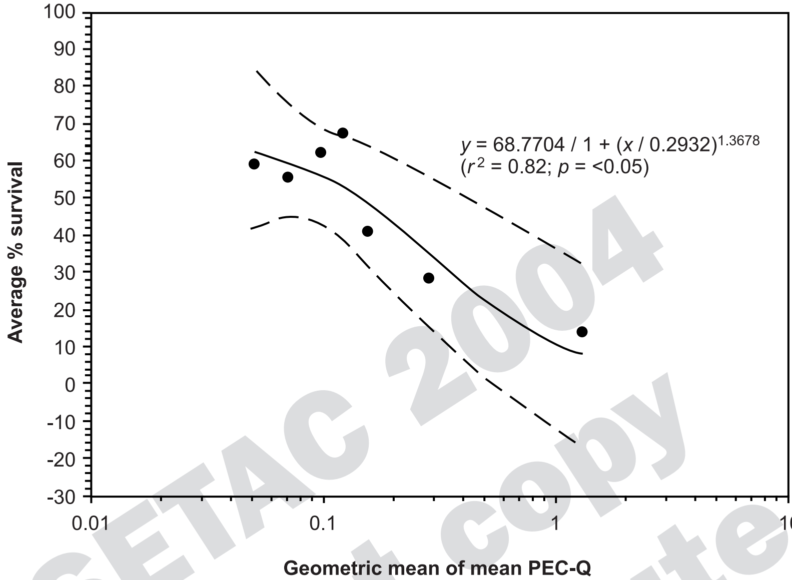


Figure 14-4 Relationship between geometric mean of the PEC-Q and survival of freshwater amphipod *A. abdita*, in 10-d whole sediment toxicity tests (MacDonald, Moore, et al. 2002)

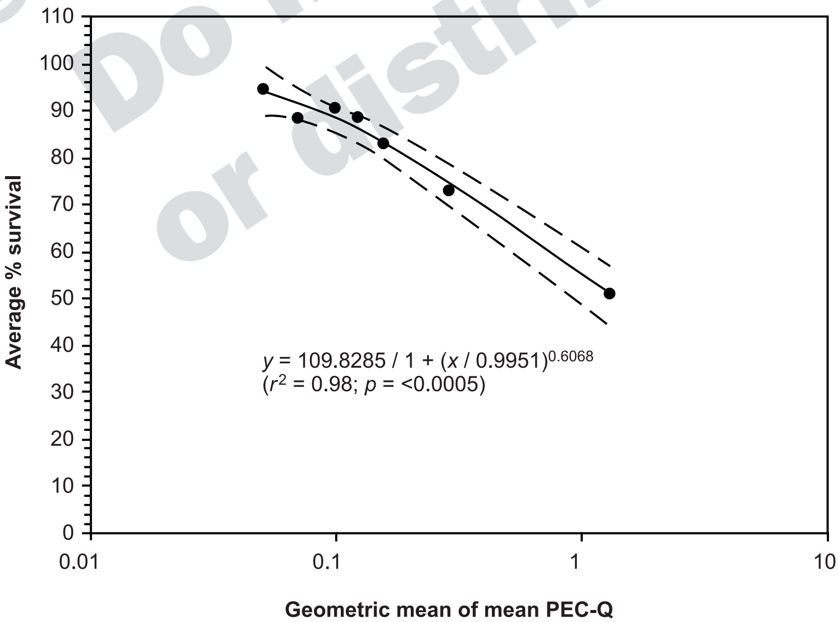
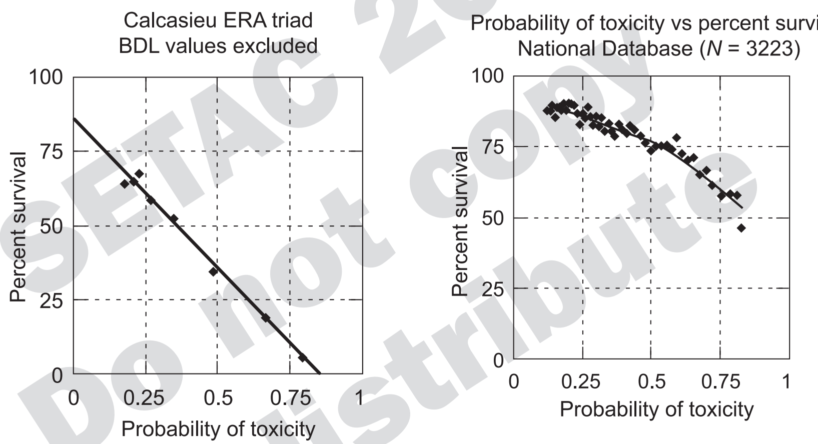


Figure 14-5 Relationship between geometric mean of the PEC-Q and survival of freshwater amphipod *H. azteca*, in 28-d whole sediment toxicity tests (MacDonald, Moore, et al. 2002)

logistic regression modeling technique, maximum probability (P-Max) value, has been shown to correlate well with observed toxicity in paired chemistry or toxicity test data (Figure 14-6). This approach shows promise at sites where only a few hazardous substances are problematic but may overpredict toxicity at marine metals-only sites (L. Jay Field, 2002, personal communication). These comparisons showed a high level of correlation with increased SQG quotients and reduced survival in the toxicity tests (MacDonald, Moore, et al. 2002). The high degree of correlation between the increase of an SQG index value and LOBS is being used to facilitate rapid settlement in several ongoing assessments.



$y = 86.01 - 101.25\,x$ $R^2 = 0.99$

$Y = M0 + M1 \cdot x + \ldots M8 \cdot x^8 + M9 \cdot x^9$	
M0	88.75
M1	6.75
M2	58.73
R^2	–0.94

Figure 14-6 Relationship between logistic regression P-Max model and survival of estuarine amphipod *A. abdita,* in 10-d whole sediment toxicity tests using the Calcasieu ERA and the Biological Effects Databases (L. Jay Field, Seattle, Washington, USA, unpublished data

Example: Benthic Community Assessment, Lavaca Bay, Texas

The conservative and reasonable estimate of injury thresholds (RCIE) approach derives from one that was developed during the negotiation of a settlement for injuries related to the Lavaca Bay CERCLA case in Texas. Multiple natural resource injury categories were assessed and quantified using the RCIE approach (then called "Reasonable Worst Case"), including the benthic community, birds, fish, and terrestrial habitats. Additionally, injury to ground water and surface water was assessed, but no compensation was sought. Mercury and polynuclear aromatic hydrocarbons (PAHs) were determined to significantly contribute to injury to the benthic community (Texas Trustees 2001).

The trustee participated in most facets of the remedial investigation, risk assessment, and feasibility phases on the Superfund process. All data created or considered was assembled into a GIS database system provided by the PRP. To assess benthic community loss of services, the following sources of information were used:

- analytical chemistry RI/FS data (extent of contamination),
- sediment quality triad (SQT) study, and
- ERA and literature survey for
    - Hg and PAH growth effects,
    - Hg and PAH survival effects, and
    - Hg and PAH reproduction effects.

Estimates of percent loss of ecological services were based on a weight-of-evidence (WOE) approach, multiple (LOEs), and consensus judgment (of the trustees and the cooperating PRP) using the results of available studies reported in the scientific literature, results of SQT, and knowledge of Texas estuarine ecosystems (Table 14-1). For Hg, the percent loss of ecological services identified and evidence used were as follows:

- The SQT found no observed decrease in survival for the amphipod *Leptocheirus* spp., no apparent reduced growth for the polychaete *Neanthes,* and no difference in the macroinvertebrate assemblages when compared to the reference area. The SQT was conducted over a Hg concentration range from 0.3 to 4.6 mg/kg, which encompasses the range of both the ERM and AET. However, sublethal toxicological endpoints such as behavioral changes and loss of reproductive capacity were not measured in SQT. To be consistent with the reasonable worst-case approach, a 10% loss of services was estimated for sediment Hg concentrations > the ERM (0.71 mg/kg) but < the benthic AET, in open water, intertidal mudflats, and fringe marsh habitats.
- A significant decrease in activity behavior of *Pontoporeia affinis* was noted at concentrations exceeding 2.15 to 3.35 mg/kg from sediment bioassays, as cited by Long and Morgan (1990). A 25% loss of services was calculated for concentrations > benthic AET (2.1 mg/kg).

Table 14-1 Loss of benthic community services values used at Lavaca Bay for open water and fringe marsh habitats (Texas Trustees 2001)

Hg in sediments	PAHs in sediments	Service (%) losses
Hg < ERM	ERL < PAHs < ERM	10%
Hg < ERM	PAHs > ERM	25%
ERM < Hg <AET	PAHs < ERL	10%
ERM < Hg <AET	ERL < PAHs < ERM	20%
Hg > AET	PAHs < ERL	25%
ERM < Hg <AET	PAHs > ERM	35%
Hg > AET	ERL < PAHs < ERM	35%
Hg > AET	PAHs > ERM	50%

- A 25% loss of services was estimated for Hg concentrations above the oyster larvae AET on oyster reefs. This injury value was consistent with the RWC approach and was based on best professional judgment.

For PAHs, the percent loss of services and identified evidence are as follows:

- In open water and intertidal mudflats or fringe marshes, a 10% percent loss of services was determined for high molecular weight PAH (HPAH) concentrations > ERL and for HPAH concentrations < HPAH ERM. This level of severity was established because of the following:
    - The NOAA ERL is based on sites with co-occurring chemicals. Additivity between Hg and PAHs was considered separately in this analysis.
    - The NOAA ERL is lower than reported apparent AETs for PAHs, including the benthic AET (Puget Sound: LPAHs > 13 mg/kg and HPAHs > 69 mg/kg), amphipod AETs (Puget Sound: LPAHs > 24 mg/kg and HPAHs > 69 mg/kg; San Francisco Bay: total PAHs >15 mg/kg; Mississippi Sound total PAHs > 205 mg/kg), and mysid AETs (Mississippi Sound total PAHs > 99 mg/kg).
- A 25% percent loss of services was estimated for sediment concentrations > HPAH ERM. PAHs detected in Lavaca Bay sediments are predominately the higher-molecular-weight PAHs. The NOAA HPAH ERM (9.6 mg/kg) is lower than reported effects thresholds (AETs) for PAHs, including the benthic AET (Puget Sound: HPAHs > 69 mg/kg), amphipod AETs (HPAHs > 69 mg/kg; Mississippi Sound total PAHs

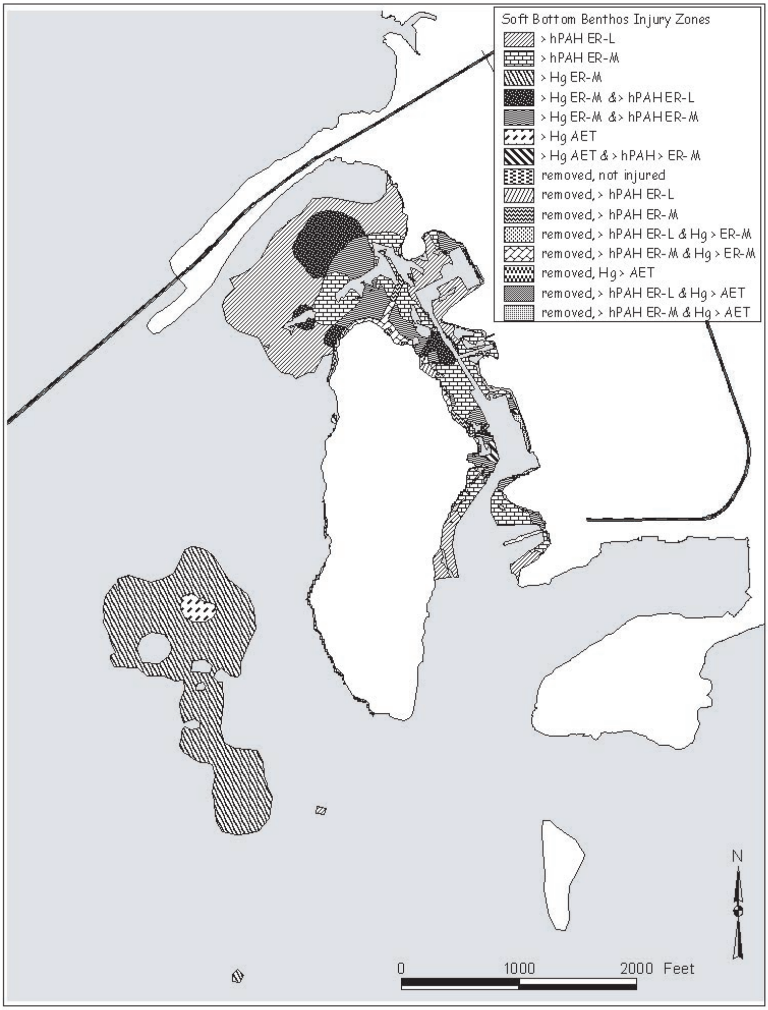


Figure 14-7 Spatially explicit distribution of injury to soft-bottom benthic community, Lavaca Bay CERCLA site (Note: Dredged 38- and 12-foot channels were excluded from the assessment.) **Authors: please provide a callout for this figure in the text.]**

> 205 mg/kg), and mysid AETs (Mississippi Sound total PAHs > 99.4 mg/kg).

- A 25% loss of services was estimated for total LPAHs (AET: 5.2 mg/kg) or total HPAH (AET: 17 mg/kg) concentrations above the oyster larvae AETs for sediments on oyster reefs.

For co-occurring PAHs and Hg,

- estimates of percent loss of services for Hg and the individual PAH constituents were assumed to be additive.

Based on available site-specific data, a greater uncertainty exists for estimating direct injury from PAHs because no site-specific studies were conducted to assess PAH toxicity. Therefore, it was conservatively determined that injury would begin where sediment concentrations exceeded the lowest reported sediment benchmark criterion (i.e., the ERL).

For locations where there were co-occurring elevated concentrations of Hg and PAHs, estimates for the percent loss of services were assigned to areas exceeding chemical benchmark criteria, assuming additivity of effects for Hg and PAHs. Additivity was assumed because no data were available to suggest either synergistic or antagonistic toxicity between these chemicals to benthic invertebrates. Therefore, where co-occurring chemicals were present, ranges were used to assess the percent loss of services, as indicated in Table 14-1.

GIS spatial analysis tools were used to describe and quantify zones where each combination occurred in Lavaca Bay. A spatially explicit map of benthic community injury was developed and served to sufficiently document the result. HEA was used to develop the number of acres of habitat required to compensate for the injury. When this and several other categories, like marsh and oyster reef, were similarly assessed, the restoration of 70 acres of estuarine marsh would be required by the trustees (Texas Trustees 2001).

Summary

The cooperative NRDA process is advantageous for all parties. The cooperating PRP saves time and money, and the public can receive compensation earlier for its losses. SQGs and indices are being used successfully at dozens of sites in Delaware, South Carolina, Texas, and Louisiana, involving federal and state oversight. In the US, courts prefer that potential litigants settle issues without resorting to litigation. This process, along with other tools, has been used to settle cases such as Bailey Waste, Orange Co., TX; Conoco EDC, Calcasieu Parish, LA; Tex-Tin, Galveston Co., TX; Brio NPL, Harris Co., TX. In these cases, RCIE or a similar approach was used, and each was settled with the State of Texas or Louisiana and the United States with a federal consent decree. Many more cases are in the process of settling. This approach allows PRPs to settle their liability issues cost effectively and to restore damaged habitats.

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